The potential of the Intelligent Buffet in measuring food intake in a laboratory setting

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Introduction

Food behavior is increasingly studied experimentally in fields such as public health nutrition, health promotion and consumer science. At the same time new development in sensor technologies have made the measurement of the impact of such interventions easier. Use of automated intelligent devices for measuring and estimating food intake and behavior has been reported by various authors [3, 8 and 11]. One of the areas that has attracted particular interest is in the study of the dynamics of food choice in "ad libitum" settings such as buffets and cash cafeterias and a number of studies have explored the placement of food items and its influence on choice and food intake [6; 7, 9, 10]. Against this background a device that could make measurements of food intake in such environments easy, precise and reproducible under the name of the Intelligent Buffet (IB). The device was developed in the context of a research facility to study behavioral nutrition - the Foodscape Lab (www.foodscaeplab.aau.dk).

Aims & objectives

The aim of the paper is to contribute to the advancement of the science of automated measuring of food behavior using intelligent devices by proposing the Intelligent Buffet (IB). The specific objectives of the paper are:

- to present the features and abilities of the Intelligent Buffet (IB) for measuring food intake and to present examples of experiments that it can be used to measure.
- to give an account of the context in which the IB functions – namely the Foodscape Lab (www.foodscapelab.aau.dk) and to provide examples of the use of the IB.
- to present examples of the use of the IB and the types of questions that can been studied
- to discuss the potential of the IB technology in commercial out of home eating settings and its potential to allow for convenient day to day monitoring of dietary behaviour.

The development of the IB

In order to be able to artificially imitate the choice situation in which consumers would act at a buffet and to be able at the same time to apply a systematic research protocol that could measure automatically food taken in this situation an Intelligent Buffet was developed. The first prototype – the FoodScale Tracker - was developed in the framework of the graduate program Integrated Food Studies (www.ifs.aau.dk) in cooperation with company Syscore and the weighing scale supplier Mettler-Toledo [1].

The goal of the development of the device was to allow researchers to be able automatically to asses: ”*who* is eating *what* in *which* amounts at *what* time” The IB was installed in the *serve area* of the lab (see Figure 1) and was developed to measure the impact of different types of food choice experiments on intake. The total set up involves a buffet, devices for identification of the individual test persons, scales to measure the amounts taken as well as overhead cameras connected to the Observer XT and that can be used as double check in play back mode to verify food choices of the subjects in the experiment. The IB was further developed from a commercial available buffet and subsequently fitted with sensors so that all test persons involved in the experiment could be accounted for when coding the data subsequently.

Figure 1. The Intelligent Buffet. To the left an overhead picture of the IB in the eat area of the FoodScape Lab. The left of the picture illustrates how the electronics is covered by the body of the buffet. The picture to the right shows the IB from the position of the overhead cameras. On the top right corner the picture shows inserted the wrist bands based on Near Field Communication technology that allows for distinguishing between the subjects taken food from the buffet. The wrist bands communicate with a receiver on the side of the buffet under each scale.

The scales were interfaced with a server to automatically detect “events” on the scale. This feature allows for setting up an experiment where all test persons are recognized through a Near Field Communication (NFC) wrist-tag. This functions the way that test persons will swipe the tag before taking food from the IB. The IB has 8 scales and allows for a buffet with a maximum of 8 different foods. After all identifications the server will detect the difference just before and just after the event in which food is taken from the buffet. The accuracy is +/- 2g

The IB technology is a setup utilising contactless technology, microcontrollers , open source electronics and a range of programming languages including C/C++, Python, PHP & bash for scripting.

A typical IB experiment is setup as follows. First the protocol of the experiment is developed. This involve describing what kind of hypothesis the experiment should be testing. The development of the intervention/experimental idea can be guided either by theory or by pure speculation. Once the intervention has been defined the IB is set up and test persons are recruited. At the same time the video recording equipment is set up to record the full experiment. Test persons are registered and enter in the eat area of the lab where the IB is located. They will then do their food choices while their behaviour is detected by the IB controller software as well as recorded by the overhead video cameras. Apart from the requirement that the subjects have to swipe the chip before they take the food – there is nothing unusual and therefore minimum bias.

The FoodScape Lab

The IB is an integral part of the FoodScape Lab that offers a variety of technology for studying behavioural nutrition in a lab setting. The FSL is used in the study of the impact of choice architectures, nudges and other food environment innovations and are aimed at developing interventions that can be used for changing food and nutrition behavior in a healthier and more sustainable direction. The experiments in the FoodScape Lab serves as a pre-test that can allow for subsequent real life testing in living lab settings where buffets are applied for instance in canteens, schools, higher education, staff restaurants etc. The facilities are offered for evidence based research and education at Aalborg University, including Integrated Food Studies and PhD courses. The services offered are available for a broad range of research projects as well as for external users.

The Lab is divided into 3 experimental areas, one control and one analytical area (see Figure 2). The experimental areas include a *cook*, an *eat* and a *serve* area fitted with a rack system for placement of overhead cameras: The control room accommodates the serves and computers that operates overhead cameras. The analytical area (*analytics* room) is fitted with workstations that are used post experiment of processing and analysis of the data that is captured experimentally. The cameras are interfaced through a http protocol and as such uses existing standard cabling.

The analytics software includes the Observer XT software the Nvivo coding and analytical software that both allows for post experiment coding of video sequences captured on the overhead cams. The ArchGIS offers the possibility of storing GIS data on the location of food "opportunities" in the coal environment such as shops, restaurants, institutions within the welfare catering systems etc. The lab offers standard statistical software and includes SPSS, SAS; R & Stat and the Master cater software that allows for converting food intake into nutrients using the official Foodcomp database (www.foodcomp.dk) and to convert food intake into climate impact (carbon equivalents) using the Simapro LCA software. The analytics software in addition include custom built software to operate and analyse data from the IB and the Dietary Intake Monitoring System - DIMS that has been developed for automated recording and estimation of amount and type of food in- and outputs in out of home eating facilities such as hospitals [5].

Sample projects using the IB

The development and fine-tuning of the equipment has been done in close cooperation with the supervisors at the Integrated Food Studies program in cooperation with the Syscore company. A few examples from the students use of the facility illustrates the kind of questions and experiments that can be approached with the IB.

The project *Nudging young men to eat more Fruit & Vegetables* [4] examined how choice architecture in a university canteen could be used to increase intake of fruit and vegetables single lunch serving among men aged 18- 29. The study aimed at determining the difference in the amount of self-served salad when increasing the amount of salad by 50 % and the accessibility of vegetables in trial compared to a control group. Although the study showed no significant difference it provided valuable insight in nature of buffet choice dynamics on efficient use of the IB.

In another study – the *Beat in the Music's Influence on the Food Intake* study [2] - it was investigated how the beat of background music would affect intake during a meal. A non participant observation approach was used for the experiment

that was set up in the lab and that used campus students as the study subjects. The experiment investigated intake at no beat, down-beat and and up-beat conditions and was conducted using the Observer XT11 for observation of behavior and the PanelCheck V 1.4.0 for statistical analysis. From the study it was concluded that the beat in the music increased the food intake as well as the number of bites.

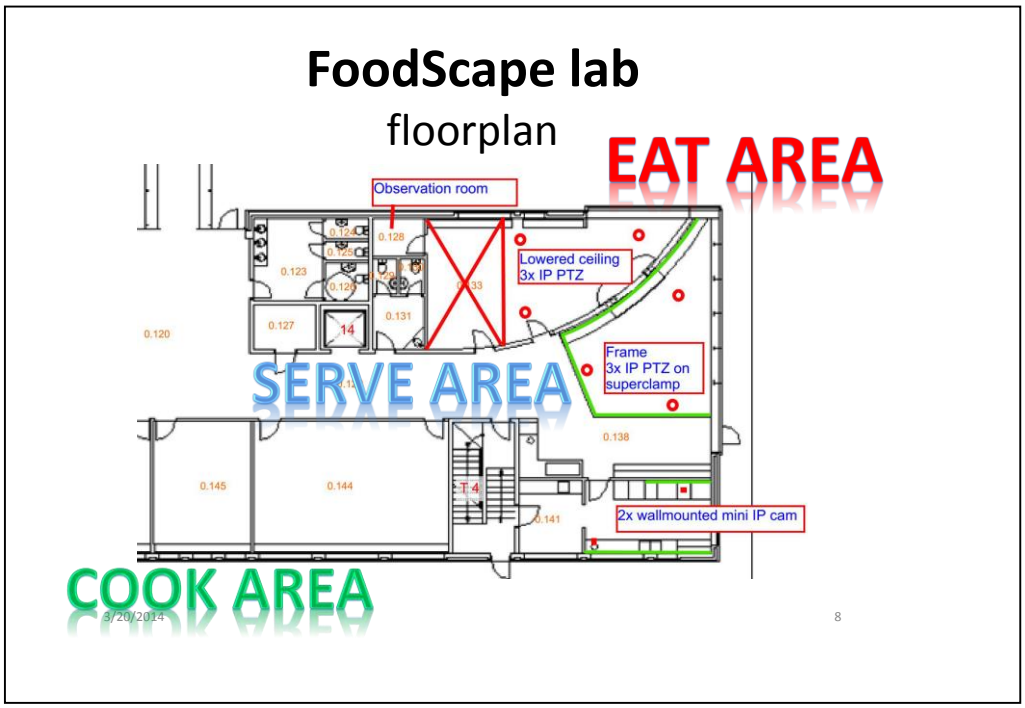

Figure 2. The FoodScape Lab. The figure shows the floorplan of the lab. The figure shows the division of the lab in an for cooking, an area for serving as well as an area for eating. All areas are fitted with a rack system allowing placement of overhead cameras. In addition to these three area the lab includes a control room that accommodates servers and computers. These are controlling the overhead cameras through joy-sticks. In the analytics room the software for post-experiment coding, analytics and other post-experiment activities are located

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References

1. Bjerregård, E & Hovmøller Hertz, (2012) The FoodScaleTracker - Semi automatiseret metode til registrering af fødevareindtag ved buffet [in Danish]. (Semi automatiseed method for capturing food intake at a buffet), MENU Research Group, AAU

2. Jensen, MEL, Granlund, S Carstensen, R, Nielsen, VH Tingstedt, N & Hansen, MV, (2012) *The Beat in the Music's Influence on the Food Intake* study. Student dissertation, University of Aalborg.

3. McCabe-Sellers B. Advancing the art and science of dietary assessment through technology. (2010) *J Am Diet Assoc*.110(1):52-54.

4. Nielsen BN, Svane, D , Ahlmann, FK, Schaldemose, H, Kongsbak, IG Atkinson, L & Wichmann, M (2013) Nudging young men to eat more Fruit & Vegetables. Student dissertation, University of Aalborg,

5. Ofei, K.T., Dobroczynski, M.T., Holst, M., Rasmussen, H. H and B. E. Mikkelsen (2014). The Dietary Intake Monitoring System (DIMS) - an Innovative Device for Capturing Patient's Food Choice, Food Intake and Plate Waste in a Hospital Setting. Proceedings of Measuring Behavior 2014, 9th International Conference on Methods and Techniques in Behavioral Research (Wageningen, 27-29 August 2014) in press

6. Rozin, P., Scott, S., Dingley, M., Urbanek, J. K., Jiang, H., & Kaltenbach, M. (2011). Nudge to nobesity I - Minor changes in accessibility decrease food intake. *Judgement and Decision Making*, 6(4), 323-332

7. Sigurdsson, V., Saevarsson, H., & Foxall, G. (2009). Brand Placement and Consumer Choice: An In-Store Experiment. *Journal of Applied Behaviour Anaysis*, 42(3), 741-745

8. Thompson FE, Subar AF, Loria CM, Reedy JL, Baranowski T. (2010) Need for technological innovation in dietary assessment. *J Am Diet Assoc*. 110(1):48.

9. Van Kleef, E., Otten, K., & van Trijp, H. C. M. (2012). Healthy Snacks at the Checkout Counter: A Lab and Field Study on the Impact of Shelf Arrangement and Assortment Structure on Consumer Choices. *BMC Public Health*, 12(1)

10. Wansink, B, (2006) Mindless eating, Why We Eat More Than We Think, 2006

11. Williamson DA, Allen HR, Martin PD, Alfonso AJ, Gerald B, Hunt A.(2003) Comparison of digital photography of weighed and visual estimation of portion sizes. *J Am Diet Assoc*.;103(9):1139-1145.